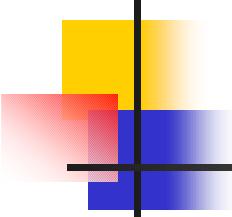


LQ search in evjj channel



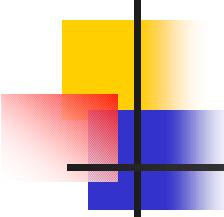
Simona Rolli (TUFTS)

-Blessing-



Issues from preblessing

- Missing Et significance cut
 - check MC background prediction vs data
 - Used cleaner sample, Z + 0 jets
 - Assess systematic uncertainty
- Discovered a typo in the macro running on data, now 2 events survive, limit got worse..



Introduction

- Some beyond the SM models assume additional symmetry between leptons and quarks
- LeptoQuarks – transition between leptons and quarks
 - Have both lepton and baryon numbers
 - λ - unknown coupling to leptons and quarks

LQ production at the TeVatron

■ Production

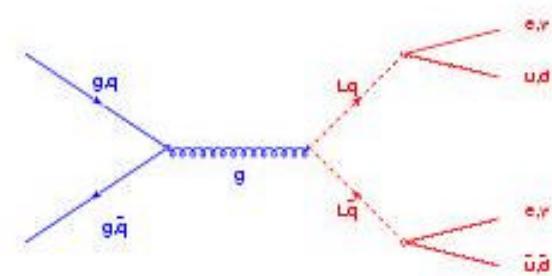
- $qg \rightarrow LQ + L\bar{Q}$
- $gg \rightarrow LQ + L\bar{Q}$
- $q\bar{q} \rightarrow LQ + L\bar{Q}$

■ Decay

- $LQL\bar{Q} \rightarrow l^+l^-q\bar{q}, l^\pm n\bar{q}q, nn\bar{q}\bar{q}$ $\beta = \text{Br}(LQ \rightarrow eq)$

■ Experimental signature:

- High pt isolated leptons (and/or MET) + jets



LQ production at TeVatron

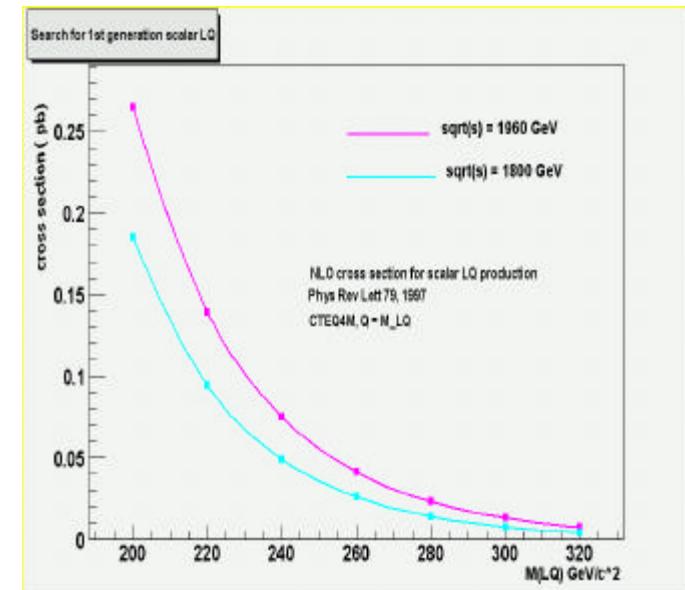
Code from Michael Kraemer (Phys.Rev.Lett 79,1997)

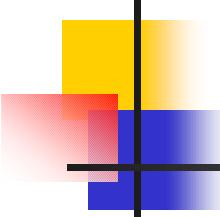
M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.185E+00
220	0.094E+00
240	0.489E-01
260	0.259E-01
280	0.138E-01
300	0.746E-02
320	0.401E-02

$\sqrt{s} = 1800 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf

M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.265E+00
220	0.139E+00
240	0.749E-01
260	0.412E-01
280	0.229E-01
300	0.129E-01
320	0.727E-02

$\sqrt{s} = 1960 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf





Previous results from Run I

- Cdfnote 4228 - July 1997
 - $m(LQ) > 180 \text{ GeV}/c^2$
 - straightforward strategy
 - cut on transverse mass to get rid of $W + 2$ jets background
- Cdfnote 4873 - June 2001
 - $m(LQ) > 182 \text{ GeV}/c^2$
 - relative likelihood technique

LQ search in evjj

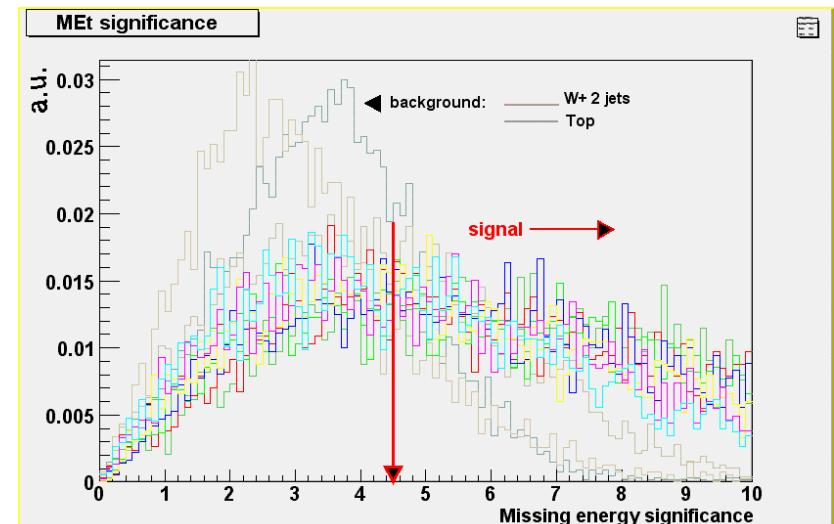
Signature: 1 electron, 2 jets and large MET

Analysis cuts

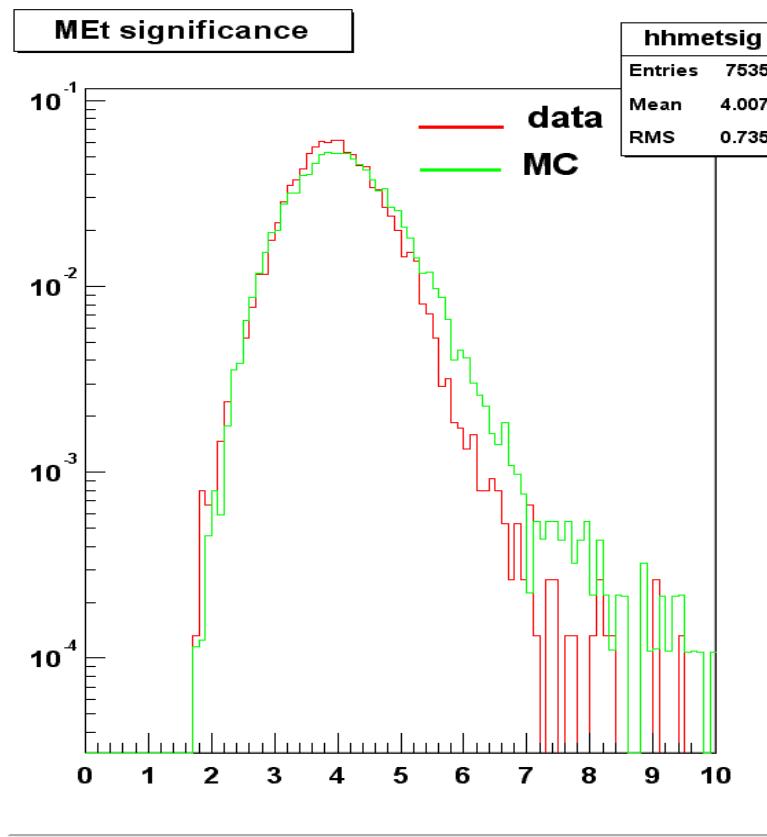
- 1 central electrons with $E_T > 25$ GeV and $\text{MET} > 35$ GeV
- 2 jets with $E_T > 30$ GeV
- $\Delta\phi(\text{MET-jet}) > 10^\circ$
- $E_T(j1) + E_T(j2) > 80$ GeV
- $M_T(e-\nu) > 120$
- $\text{Met}/\sqrt{\sum E_T} > 4.5$

similar to note 4228, but for metSig cut

Events with 2 central electrons are rejected
(to be orthogonal to eejj analysis)

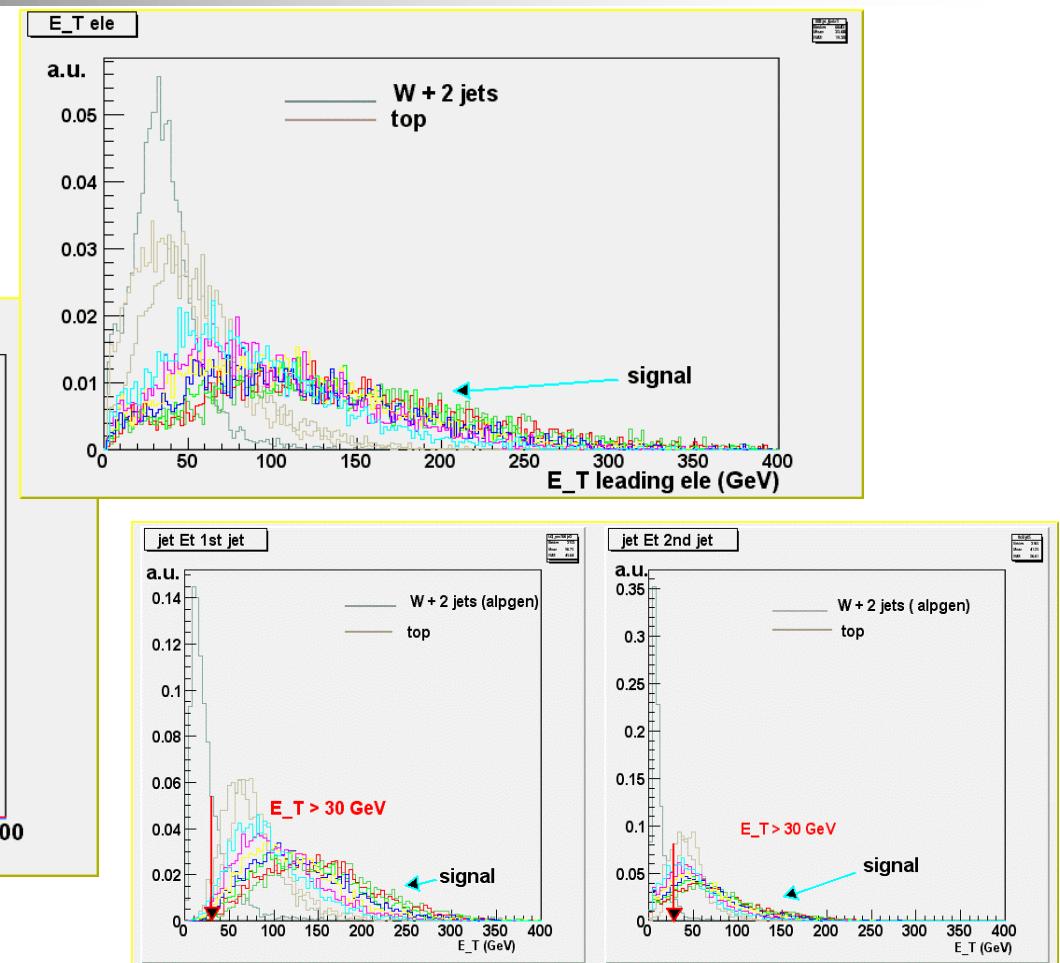
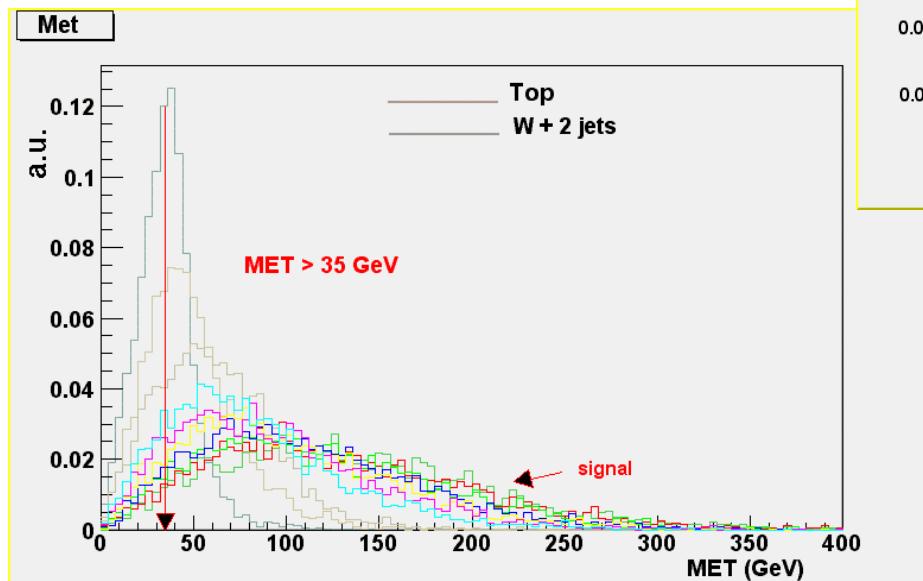


Missing E_T significance

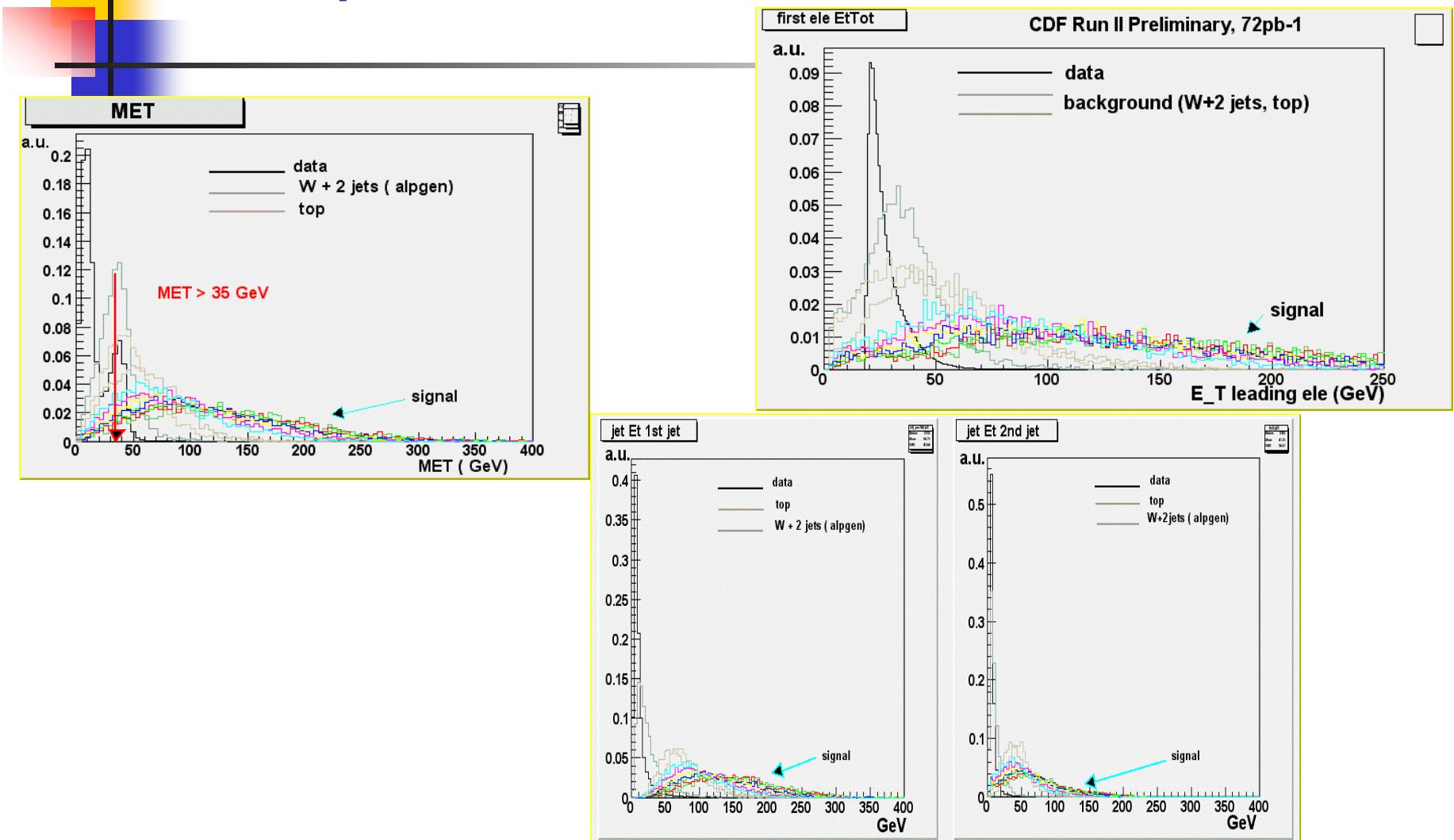


See later for
associated
systematics

MC distributions

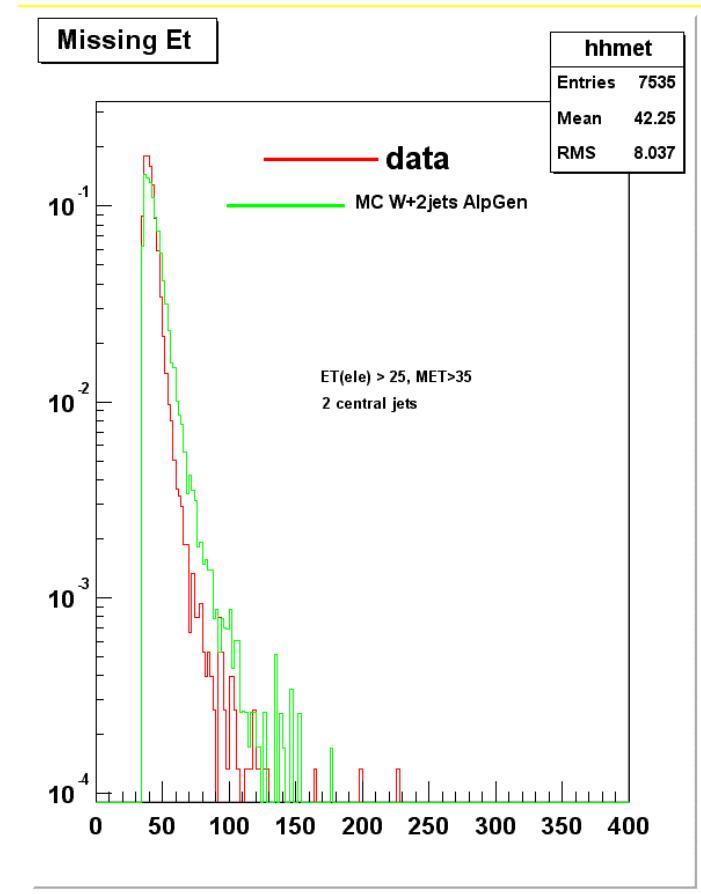


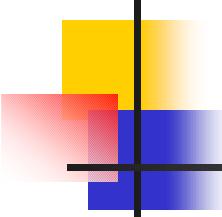
Comparison with data



Met corrections

- Jets have been corrected for relative response, time dependence and energy scale (level 3);
- MET has been “*corrected*” after correcting the jets energies;
- selection id done using corrected quantities.

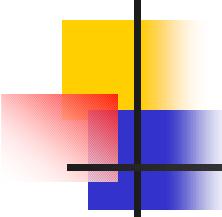




Tools

- Signal generated and reprocessed with 4.9.1
 - 5000 events at masses from 160 to 280
 - run number 151435
 - full beam position
 - talk GenPrimVert
 - BeamlineFromDB set false
 - sigma_x set 0.0025
 - sigma_y set 0.0025
 - sigma_z set 28.0
 - pv_central_x set -0.064
 - pv_central_y set 0.310
 - pv_central_z set 2.5
 - pv_slope_dxdz set -0.00021
 - pv_slope_dydz set 0.00031
 - exit
- eN (4.9.1)used for ntuple analysis
 - <http://ncdf70.fnal.gov:8001/talks/eN/eN.html>

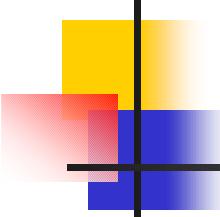
Same as cdf6338



Efficiencies & acceptance

$$\epsilon_{\text{tot}} = \epsilon_{\text{Acc}}(M) \times \epsilon_{\text{ID}} \times \epsilon_{z0} \times \epsilon_{\text{trig}}$$

- Trigger
 - Top/EW - as in Z' analysis we use $99.1 \pm 0.1\%$
- Efficiencies for electron selection cuts
 - Z' analysis
 - $\epsilon_T = 89.6 \pm 0.5$
- Other
 - efficiency on the vertex cut ($|z_0| < 60$ cm) 95.2 ± 0.1 (stat) ± 0.5 (sys) (Willis Sakumoto)



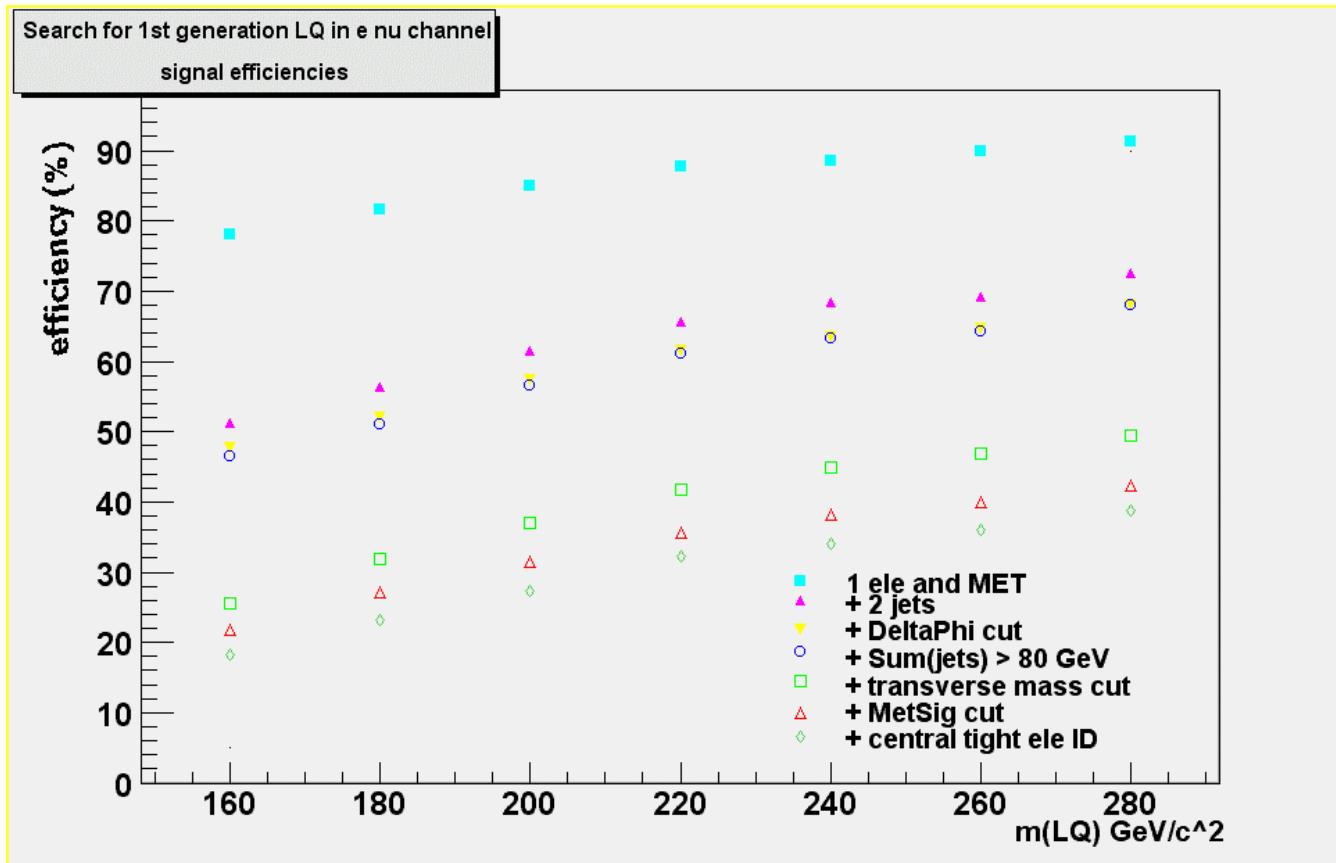
Electron ID (Z' analysis)

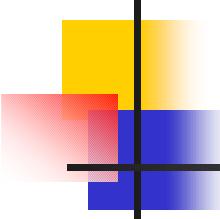
- Central electron tight

- $E_t \geq 25 \text{ GeV}$
- $p_t > 10 \text{ GeV}$
- $\text{hadem} \leq 0.055 + 0.00045 * E$
- $E/p < 4$ (for $E_T < 200 \text{ GeV}$)
- $\text{iso4e}/\text{emet} < 0.1$ (0.2 for second central loose)
- $|\Delta x| < 3.0$
- $|\Delta z| < 5.0 \text{ cm}$
- Fiducial = 1
- $I_{\text{sh}} < 0.2$

$$\epsilon_T = 89.6 \pm 0.5\%$$

Total acceptance

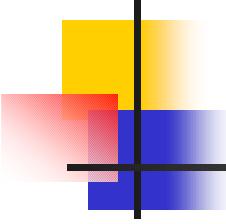




Expected signal events

Number of expected events in 72 pb⁻¹

Mass (GeV/c ²)	n Theory CTEQ4M (pb)	n Theory CTEQ4M (pb)
	$Q^2 = M_{LO}^2/4$	$Q^2 = 4M_{LO}^2$
160	7.1	6.2
180	4.8	3.8
200	2.8	2.3
220	1.7	1.4
240	0.99	0.8
260	0.6	0.5
280	0.34	0.3

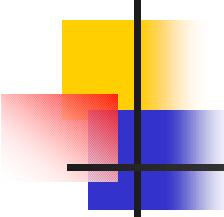


checked

Background

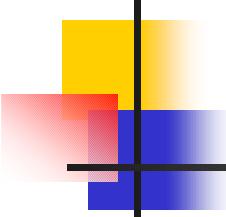
- tt with both $W \rightarrow e\nu$ 0.13 ± 0.02 events
 - pythia
- tt decaying into l + jets 0.026 ± 0.012 events
 - pythia
- $W + 2$ jets
 - alpgen + PS 1.60 ± 1.10

Total 1.73 ± 1.47



Data sample

- btop0g (inclusive electrons) stripped from bheI08 and (4.8.4 Production)
- Inclusive-ele_484_REMAKE
- events selected from Ele_18 && Ele_70 triggers
- good runs from March 23 2002 to Jan 12 2003 (141544 - 156487)
- $70.2 \text{ pb}^{-1} \times 1.019$
 - 1 isolated electrons
 - One tight (central)
 - MET $> 35 \text{ GeV}$
 - At least 2 energetic jets



Data sample

```
module clone Prereq HPTE
module enable Prereq-HPTE
module talk Prereq-HPTE
  L1Accept set true
  L2Accept set true
  L3Accept set false
  L3TriggerNames set ELECTRON70_L2_JET \
    ELECTRON_CENTRAL_18 \
    ELECTRON_CENTRAL_18_NO_L2 \
    W_NOTRACK \
    W_NOTRACK_NO_L2 \
    Z_NOTRACK
  debug set false
exit
exit
```

```
module clone StripSingleE HPE2
module enable StripSingleE-HPE2
module talk StripSingleE-HPE2
  elePtMin set 15.0
  etCalMin set 70.0
  delXMin set 3.0
  delZMin set 5.0
  show
exit
```

```
module clone StripSingleE HPE1
module enable StripSingleE-HPE1
module talk StripSingleE-HPE1
  elePtMin set 9.0
  etCalMin set 18.0
  delXMin set 3.0
  delZMin set 5.0
  EoPMax set 4.0
  lshrMax set 0.3
  hademMax set 0.125
  show
```

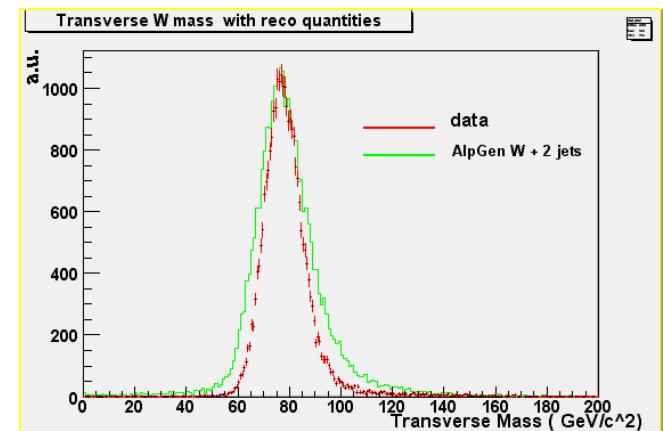
W cross section

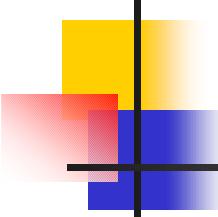
Relaxing the MET cut to 25 GeV we obtain 44510 candidate W events

Assuming the same background expectation as in CDF6300 (scaled to the increased Luminosity) we obtain:

$$\sigma \text{Br}(W \rightarrow e\nu) = (N_Z - N_{\text{BG}}) / (A_W \cdot e_{\text{ID}} \cdot e_{\text{trig}} \cdot e_{z_0} \cdot L) = \\ 2.93 \pm 0.01 \text{ (stat)} \pm 0.13 \text{ (sys)} \pm 0.27 \text{ (lumi)} \text{ nb}$$

Acceptance	$24.6 \pm 0.04 \pm 1.05 \text{ (sys)}\%$
ID efficiency	$86.42 \pm 0.5\%$
trigger efficiency	$99.9 \pm 0.1\%$
z_0 efficiency	$95.2 \pm 0.5\%$
Observed events	44510
estimated bkg	$2590 \pm 100 \text{ (stat)} \pm 900 \text{ (sys)}$
integrated L	72.0 ± 0.45

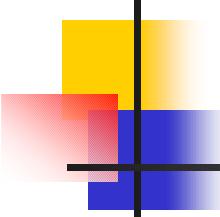




Analysis results

2 events survives the analysis cuts:

Number of events with 1 ele > 25 && MET > 35	26413
evt with 1 ele, MET and \geq 2 jets (30 30)	241
evt with 1 ele, MET and \geq 2 jets and dphi cut	196
evt with 1 ele, MET and \geq 2 jets and dphi cut and 2jet_80	156
evt with 1 ele, MET and \geq 2 jets and dphi cut and 2jet_80 and T mass cut	23
evt with 1 ele, MET and \geq 2 jets and dphi cut and 2jet_80 and T mass cut and metsig 2	



Surviving event

Run number = 143980, Event number = 3789228
(28 April 2002, no Si good run list)

Met significance = 4.31371

MET = 63.7017

Corrected Met significance = 4.51987

Corrected MET = 66.7461

ele Et = 77.7476

after Jet corrections

Et first jet = 57.988 (Et first jet uncorrected = 57.6917)

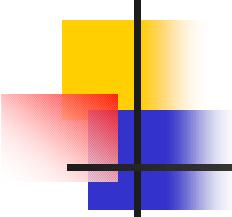
Et second jet = 30.4687 (Et second jet uncorrectd = 27.3702)

Emf 1st jet = 0.177992

Emf 2nd jet = 0.338102

η first jet = -0.446346

η second jet = -1.25196



Surviving event

Run number = 151477, Event number = 366009

Met significance = 4.92167

MET = 70.1564

Corrected Met significance = 5.16262

Corrected MET = 73.5911

ele Et = 72.1805

after Jet corrections

Et first jet = 49.1056

Et second jet = 31.4024

Et first jet uncorrected = 44.0075

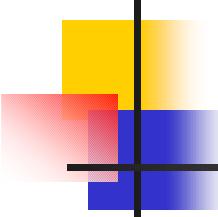
Et second jet uncorrectd = 29.6325

Emf 1st jet = 0.930684

Emf 2nd jet = 0.832076

ETA first jet = -0.0324139

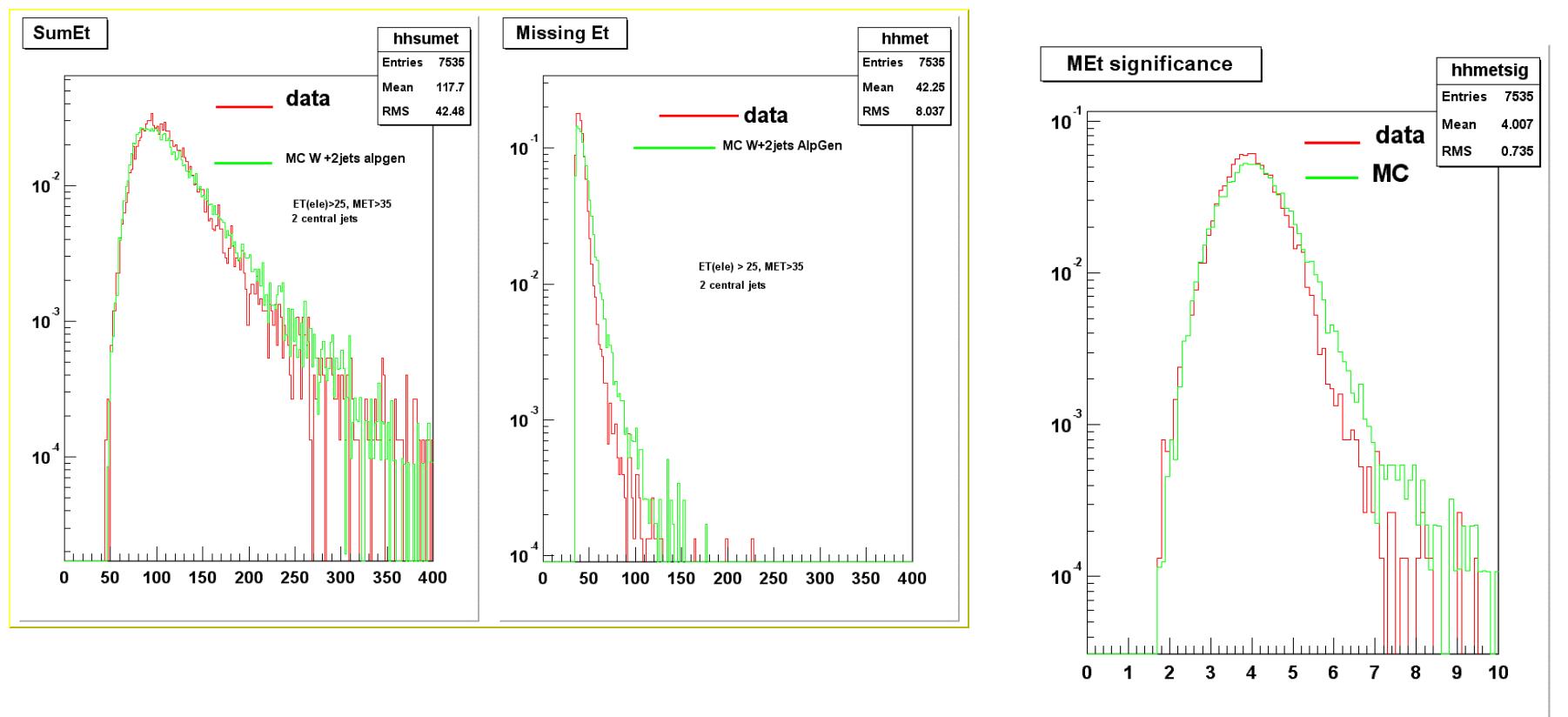
ETAssecond jet = 0.61215



Systematic uncertainties

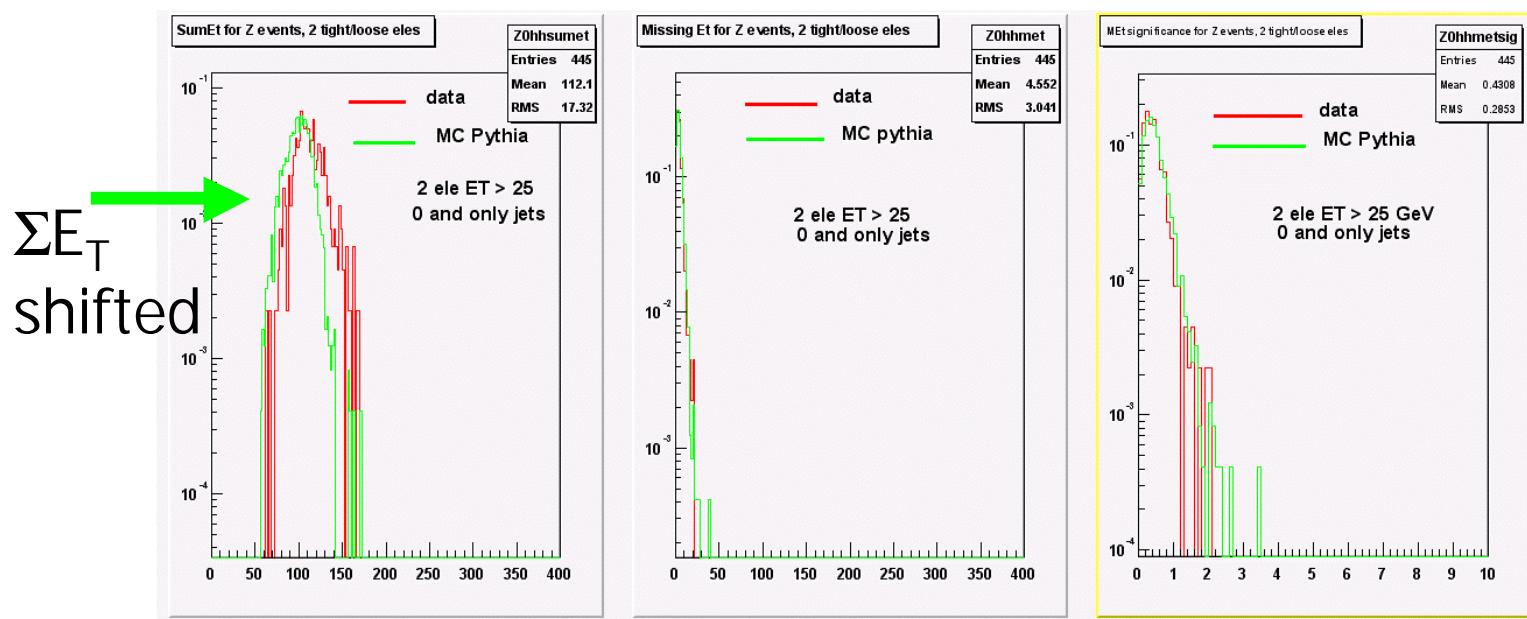
- Luminosity: 6%
- Acceptance
 - pdf 4.3% (from run I)
 - statistical error of MC 2.2%
 - jet energy scale (Level 3) 2.9 - 0.7 % (absolute uncertainty)
 - jets corrected for energy scale, time dependent and relative response
 - jet energy scaled of systematic uncertainty + 5% (energy scale + 5% data/MC adjustment); 0.08 to 0.01 systematic effect on signal acceptance
- Electron ID efficiency (Z')
 - statistical error of $Z \rightarrow e^+e^-$ sample: 0.8%
 - energy scale : 3.7%
- Event vertex cut : 0.5% (Willis)

Systematic from MetSig cut



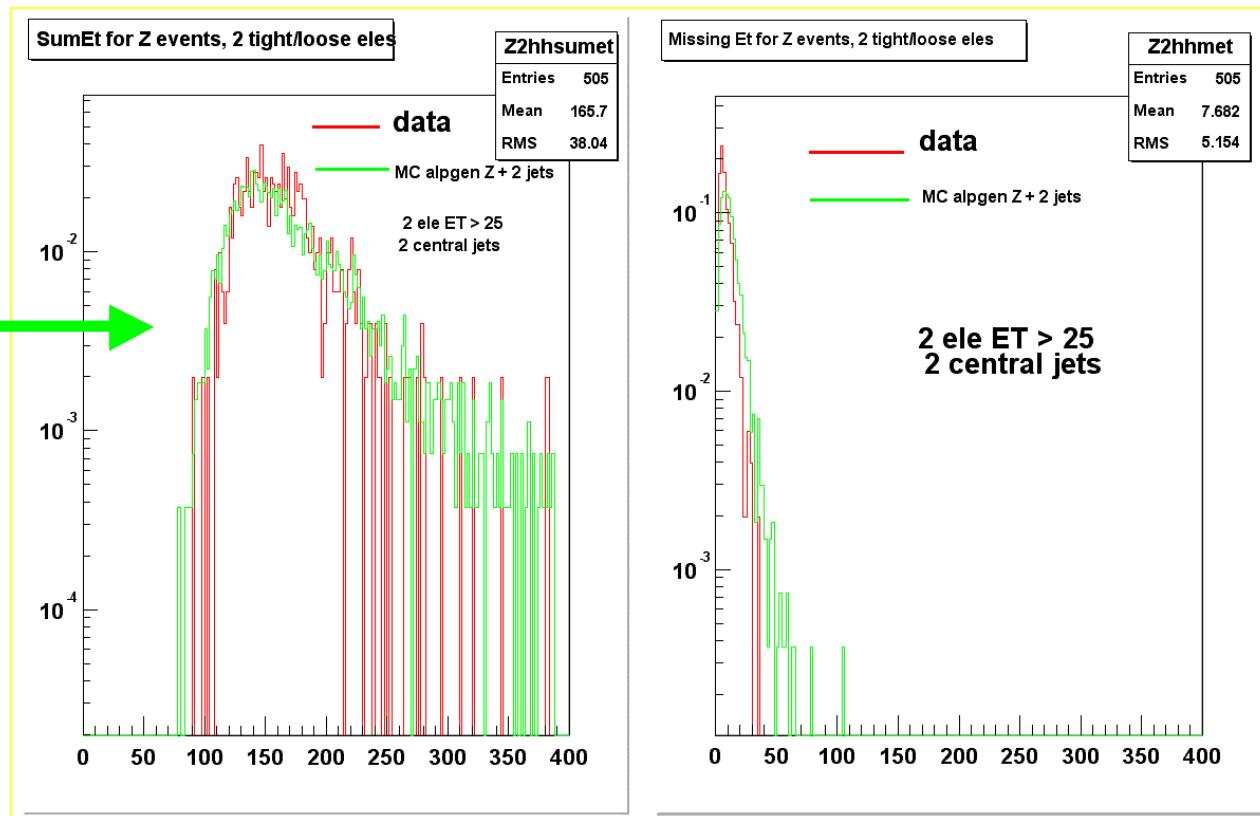
Systematic from MetSig cut

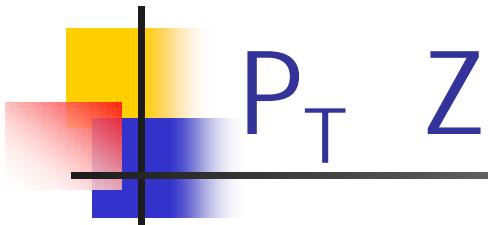
Z events (0 jets)



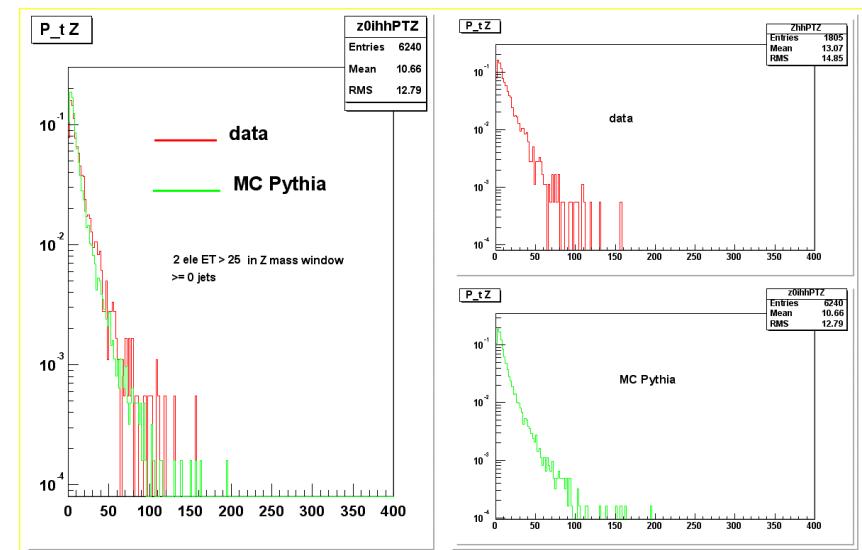
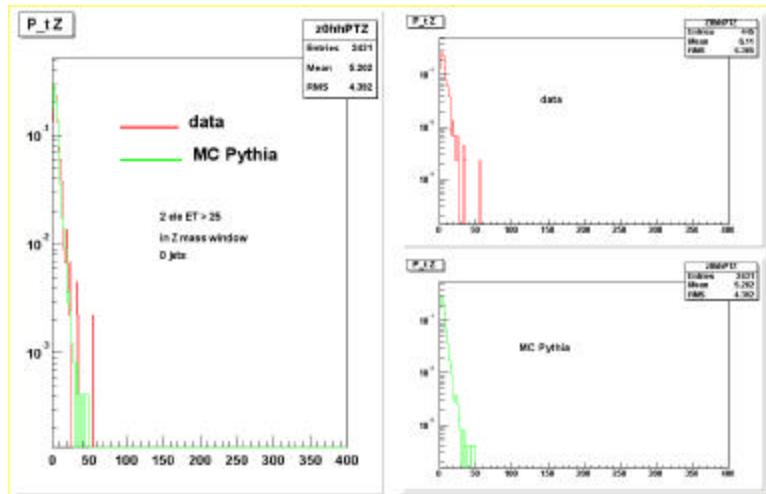
Sumet and MET in Z + 2 jets

ΣE_T
shifted



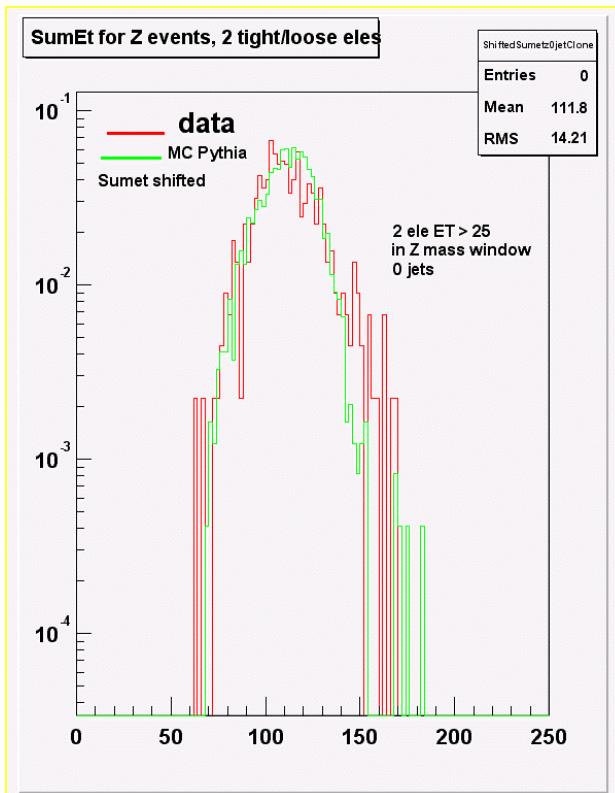


P_T Z (0 jets)

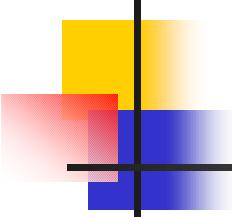


inclusive

Sumet in Z events

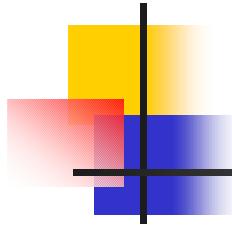


- We decided to use the shift in the Z events Sumet (~ 15 GeV) as a measure of our uncertainty in the final MetSig cut.
- We calculated the shift in acceptances (signal and MC bckg) due to shifting the Sumet in the final MetSig cut
- final systematic is of order of 0.02-0.01% (small to large signal masses)



Number of events LIMIT

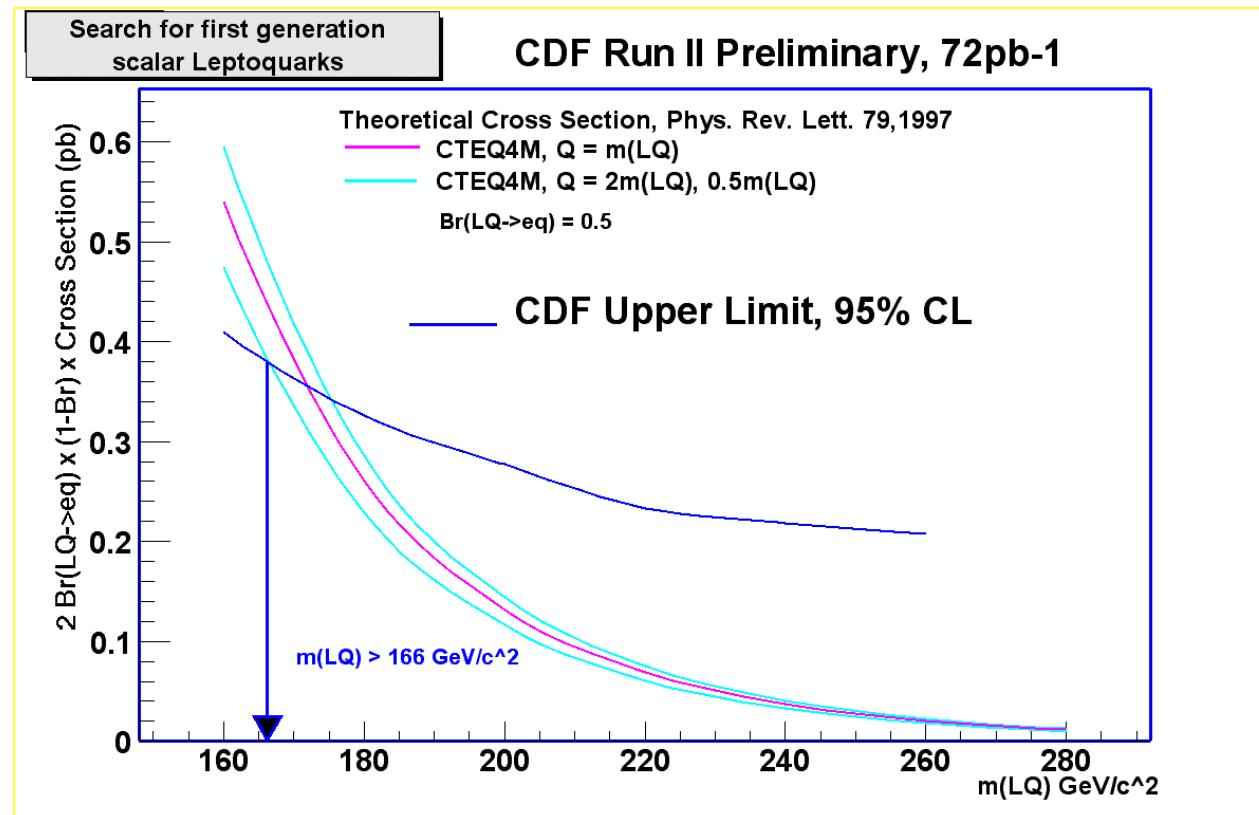
Mass	95%CL sigma (pb)	N Theory CTEQ4M (pb) $Q^2 = M^2/4$	$Q^2 = 4M^2$
160	5.385	7.82965	6.2374
180	5.377	4.70948	3.77748
200	5.373	2.79175	2.2586
220	5.369	1.73644	1.40295
240	5.368	0.999265	0.806532
260	5.367	0.581352	0.465082
280	5.365	0.349482	0.278472



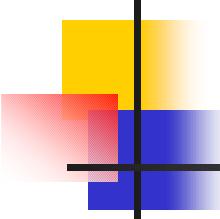
Cross Section limit

Mass	95%CL nev (pb)	σ Theory CTEQ4M (pb) $Q^2 = M^2/4$	$Q^2 = 4M^2$
160	0.409223	0.595	0.474
180	0.325967	0.2855	0.229
200	0.277142	0.144	0.1165
220	0.233443	0.0755	0.061
240	0.218638	0.0407	0.03285
260	0.207718	0.0225	0.018
280	0.192659	0.01255	0.01

Cross section Limit



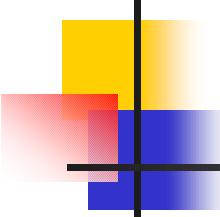
$M_{LQ} > 166 \text{ GeV} @ 95\% \text{ CL}$



Conclusions

- A preliminary 95% CL cross section lower limit as a function of M_{LQ} , for leptoquarks decaying with 100% branching ratio into eq ($\beta = 0.5$) has been set.
- Comparing it to the NLO theoretical predictions for leptoquark pairs production at the TeVatron, an upper limit on the Leptoquark mass is obtained at

$$m_{LQ} > 166 \text{ GeV}/c^2$$



Plans

- Bless this result and later a combination with eejj and METjj for EPS
- revise everything with new software releases, reprocessed dataset and additional luminosity for LP